BCD/ACD developments for Cavities

- Several improvements are needed on both BCD/ACD
- A significant amount of R&D work is needed to resolve issues
  - Quality control of the processes of cavity preparation needs improvement
  -

Processing BCD/ACD developments - 1

- BCD=EP, 6-800° C & EP
  - Need to confirm the amount for damage removal.
    - DESY will get more statistics on nine-cells
- ACD
  1. Centrifugal barrel polishing 40 µm BCP 10 µm + 750° C & EP 50µm to 75 µm
     - Is Mechanical better alternative?
       - Good for defect removal
       - Good initial surface roughness
       - Environmentally friendly
       - Q disease issue
     - KEK will work on five- or nine-cells
  2. BCP & EP ????

Processing BCD/ACD developments - 2

- Electropolish improvements:
  - Control of HF concentrations during processing (sulphur)
    - Sample measurements exist at Saclay
    - Jlab: Automated addition of HF during process (relate to current density monitor)
    - DESY: Monitor the current density, improved heat exchanger
    - KEK:
  - Control of Nb content during processing other contaminants?
    - Some sample measurements exist (Saclay, KEK)
    - On EP system
      - Calculated (KEK,JLAB,DESY)
      - Measurement (online, offline)
  - Monitoring removal rate
    - Online (Cornell ?)
    - Offline:
      - Witness Samples (DESY,JLAB)
      - Weight (KEK,JLAB,DESY)
      - Ultrasonic (KEK,CORNELL, JLAB)
  - Are we working in the right part of the I-V curve?
    - Dc (DESY, KEK, JLAB)
      - Voltage control (DESY,KEK,JLAB)
      - Current(JLAB, HENKEL)
      - Feedback (INFN Legnaro)
    - pulsed

Processing BCD/ACD developments - 2a

- Can we get the right current distributions for uniform etching?
  - Measurement off the removal dependent on position, then calculate (KEK)
  - Grooved in equator region (JLAB bench)
  - Software for calculation (DESY)
  - Fluxgate magnetometer (INFN Legnaro)
- Measure surface roughness as process QA - can we do it?
  - Witness samples might be insufficient
  - Measure inside the cavity ?????
- Orientation
  - Horizontal (KEK,DESY,JLAB, HENKEL, INFN)
  - Vertical (CORNELL)
- Other acid compositions
  - Increase HF (KEK, Saclay)
  - Buffering
    - Lactic (JLAB, half cells, test bench)
  - add water plus HF (Saclay)
  - Nitric acid (KEK)
- Develop a technique to EP cavities in helium vessels (understand and minimize voltage drop along cavity)
- Mass production
  - Quick connect (DESY, JLAB?)
  - Acid recycling (KEK)

Processing BCD/ACD developments - 3

- Determination of optimum post-etching rinse processes
  - Rinse fluid
    - Water (DESY, JLAB, KEK, ….)
    - Hydrogen peroxide (KEK, CORNELL)
    - Ozonated water(KEK)
    - Alcohol (DESY, JLAB?)
    - Duration? Output water quality parameters?
  - Rinse & dump? Steady flow?
- Post-rinse handling
  - Manipulation
    - Cleaning of the outside of the cavity
      - Ultra-sound (DESY, JLAB?)
      - HPR (KEK)
  - Storage until HPR
    - baseline is to keep it full of water

Processing BCD/ACD developments - 4

- Ultra-pure high-pressure water rinsing
  - Improve water quality with additional/better monitoring
    - Particulates - both
      - Input
        - » Online (High Pressure side: Jlab; Low pressure: DESY)
      - output streams
        - » Online (Jlab?)
        - » Offline (DESY)
    - Total oxidizable carbon
      - Need reliable system (Specification? Oil contamination?)
        - » Online (High Pressure side: Jlab; Low pressure: DESY)
      - Active carbon filter (KEK)
      - Degassing of oxygen against bacteria (KEK)
      - Sanitizing procedures (JLAB, DESY?)
    - Dissolved solids
      - Full water analysis (JLAB 1x year)
    - Resistivity (all)
  - Improve cleaning power
    - Optimize nozzle material, geometry, size (JLAB)
    - Optimize flow rates, impact angles (JLAB, INFN Milano)
    - Optimize pressure (JLAB)
    - Investigate electrostatic charging
      - Change of oxide structure, monitoring needed
  - Optimize duration of rinse

Processing BCD/ACD developments - 5

- Post-HPR handling:
  - Drying procedures
    - Laminar flow in clean room (DESY, KEK, JLab)
    - Vacuum (DESY, KEK, JLab)
      - Understanding of the best Vacuum system needed(JLAB ?)
        - » Oil-free (DESY ?)
        - » No particulate contamination
    - Hot nitrogen drying (JLAB)
    - Heating
      - With evacuated cavity (KEK): ‘In-situ’ bake
      - Air bake (SACLAY)
    - Alcohol rinse

Processing BCD/ACD developments - 6

- Storage until test
  - air, vacuum, clean nitrogen, argon, ????
- Assembly
  - Standardisation of cleaning methods for sub-components
    - Cf. Mass production
    - QA of particle counts etc.
    - Main power coupler:
      - » Can it be cleaned like the other components (before processing)?
  - Documentation of assembly procedures
    - QA of particle counts etc.
  - Training of people
- Bakeout at ~120° C
  - Optimize low-T bakeout temperature and time (Saclay)
    - Part of the drying process (KEK)
  - Air bakeout (Saclay)
- Backfill
  - Argon
    - Avoid nitride formation during tank welding
    - DESY
    - KEK: After RF test only Argon
  - Nitrogen
    - Jlab, DESY (single-cells), CEA ?
    - KEK: Before RF test

Processing BCD/ACD developments – 6

- High-temperature heat treatments
  - Integration of furnaces into clean room?
  - 600-800° C
    - Optimise temperature and duration
    - Attach furnaces to cleanroom
    - Cavity under separate vacuum
  - 1400° C
    - High RRR needed?
      - Data analysis of cell Eacc/RRR
      - High RRR sheets from supplier

Testing developments

- R&D phase
  - Improve cold test diagnostics
    - Extend thermometry to all tests
    - Visible light monitoring of helium boiling
  - We need to do more post-test forensics
  - All passband modes measured
  - Data on dark current
    - VT:
      - Relation of X-rays to dark current???
      - Measure X-rays in all directions
    - Module test stand
      - Faraday cup

Test Sequence BCD

- BCD:
  - Vertical low-power test of all cavities
    - Measure 8 cavities in one cooldown
    - Sorting ?
    - Different manufacturers for cavities and module (interface)
  - High-power test only few single cavities
  - All sub-components tested
    - Need to improve quality control of feed throughs, couplers, tuner motors
  - Module power test
    - First X % modules, then every Y module
    - Must include dark current measurement

Fabrication ACD developments

- EP half-cells
- Preparation of auxiliary components
  - Cleaning and handling kept consistent with cavity treatments
- Have we got the right gasket material?
- Can we improve flanges to reduce the likelihood of contamination?

Material ACD developments

- Investigate EP with single-crystal/large-grain material
  - Phonon peak
- Optimum heat transfer by reduction of Kapitza
- Investigation on Flux trap n Nb/Cu clad

Mass Production Issues for Preparation Process

- Simplify assembly procedures
- Reduction of hardware counts
- Minimize contact with humans
  - Tooling, Fixtures
  - Investigation of automation
- Determine equipment MTBF
- There is a need to develop QA processes to assess particulate contamination of the inner cavity surface